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ANALYSIS OF FLARES OBSERVED DURING THE SOLAR MAXIMUM YEAR

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INTRODUCTION

This report encompasses three major projects:

(1) Qualitative characterization of the H-alpha profiles of the flare of 5 November 1980 at 2233 UT; done by Sara Martin and Stephen Walton.

(2) The construction of a film projector/digitizer for the purpose of projecting half-frame 35mm images onto a television camera detector; supervised by Martin and Walton.

(3) Images of solar plages near the limb in broadband continuum, and analysis thereof, by Steven Robinson.

These projects are described in the respective three sections of this report.

I. THE 5 NOVEMBER 1980 FLARE

We selected the major flare which occurred on 5 November 1980 for detailed analyses of its fine structure, especially during its flash phase. This flare was chose.. because excellent observations are available from the SMM satellite as well as from the Big Bear, San Fernando and Owens Valley Observatories.

From the Big Bear Solar Observatory we have high resolution filtergrams of the flare taken in H-alpha and in the He I D3 line. The D3 filtergrams show only the

core of the flare in emission, while in H-alpha the entire chromospheric flare is observed in emission. Fine structure with dimensions of only a few arc seconds are seen in D3.

Data of excellent quality were obtained of this event by the Multi-Slit Spectrograph (MSS) operating at San Fernando Observatory. During the flare which started at 22:33 UT, the MSS spectrograph was operated in the "flare mode", with spectra taken every two seconds. Because the slits of the spectrograph were stepped approximately 2 arc seconds between each exposure and there are 20 steps between successive exposures at the same location, the temporal resolution is 40 seconds for each flare point observed. The multi-slit spectra allow us to readily identify very small emission elements within flares, a unique characteristic of this instrument.

The two kernels have distinctly different spatial and spectral characters in the H-alpha profiles observed with the MSS. This flare is basically a two-ribbon event, with most of the emission in the two flare kernels immediately north and south of the neutral line, as shown in Figure 3(b) of Hoyng et. al. (1983 Ap. J. 268, 865). The southern kernel has a small and very intense emitting region, with a narrow, bright H-alpha profile about 2 angstroms in width with no central reversal from a region

about 4 arc sec in size. The emission in the northern kernel is spread over an area some 20 arc sec across with considerable fine structure in the line profiles at the 2 arc sec level.

The fine structure in the emission from the northern kernel will be investigated in detail; some qualitative conclusions have already been reached. Most of the emission is in the form of relatively faint symmetric profiles 1 to 2 angstroms in width with no central reversal. However, the southernmost part of the northern kernel (that part a few arc seconds from the neutral line) shows a small region of emission whose H-alpha profile is both much wider, some 5 angstroms, and is clearly centrally reversed in the frame taken at 22:34:34. This is the only portion of the flare to show either of these spectral characteristics. This area also appears to be cospatial with the point of the brightest He D3 emission seen in the Big Bear filtergrams. The central reversal has disappeared by 22:35:05, the time of the next frame at this location, although the emission remains broad.

These results can be understood qualitatively as results of the characteristics of the corona overlying the flare chromosphere. Model flare chromospheres were calculated by Ricchiazzi and Canfield (1983, Ap. J. 272,

739) and the resulting H-alpha profiles were calculated by Canfield, Gunkler and Richiazzi (1983 preprint). They show that only high values of the flux of energetic electrons from the corona onto the chromosphere produce H-alpha profiles with obvious broad wings, and that only high values of the overlying coronal pressure can produce strong H-alpha profiles that are not centrally reversed. It is our hypothesis that the narrow profiles without central reversal result from material evaporated into the corona by the immediately preceding flare at 22:26 UT which causes a higher density, and hence higher pressure, in the corona overlying the 22:33 flare. Chromospheric evaporation on timescales of 3 to 4 minutes was observed by Acton et. al. (1982, Ap. J. 263, 409) in H-alpha profiles.

The one broad profile observed may be the point at which the high-energy electrons from the presumed magnetic reconnection at the top of the flare loop impinge the corona. If this is the case, these electrons strike the chromosphere only in the northern flare strand, and in a region which is less than 2 arc seconds, or 3000 km, across. The narrow profiles in the rest of the flare indicate that the main source of heating in those areas is thermal conduction.

The next analysis to be done on these data is

digitization of the MSS frames and conversion of the H-alpha profiles to intensities. This will allow us to attempt quantitative matching of the observed profiles to model flare chromospheres, and measurement of the total energy released by the flare in the H-alpha line.

II. THE FILM PROJECTOR/DIGITIZER

A Vanguard Model NNN 35mm film projector has been extensively modified for use as a film digitizer. This projector has a film transport and rear-projection screen which allows viewing of three successive 35mm movie frames. We have added an optical system to this projector which allows all or parts of an 18 by 24 mm frame to be projected onto the detector of a camera through use of a beamsplitter which allows use of the rear-projection screen. The image can be magnified by factors up to about 10 in linear size.

Much time and experimentation was necessary to convert this projector. The optics for the television image has three lenses, the final one of which is mounted on an optical stage with the camera to allow it to move in order to change the size of the projected image. In addition, both a transfer lens which minifies the film image and a field lens to image the aperture of the transfer lens onto the aperture of the final lens proved

necessary to prevent vignetting. We also plan to replace the current light source, a projection lens with a filament whose images can be seen in the optical system, with a custom mercury-vapor lamp which will provide the bright and highly uniform illumination required.

We are currently using a vidicon television camera as the detector, with the camera output connected to the Eyecom III Image Processing System which was just installed at Big Bear Solar Observatory. The Eyecom III accepts a video input and digitizes it to 640 by 480 pixels with 256 gray levels. The current instrument is capable of acceptably digitizing the central areas of a movie frame, and we plan to use it for the purpose of digitizing the film taken of the 5 November flare with the MSS in the near future.

III. LIMB PLAGE OBSERVATIONS

In an effort to settle the question of the contrast of solar plages near the limb (see Chapman and Klabunde 1982, Ap. J. 261, 387, for a recent controversial result), Steven Robinson has taken over 200 images in six broadband colors of solar plages near the limb during periods of good seeing at Big Bear Solar Observatory. Most of the effort on this project to date has involved software development necessary to efficiently process

such a large amount of data. This has focused on several areas:

(1) Calibration of the data to relative intensities from the digitized video images. This phase is complete.

(2) Reduction of the images to annuli for measurements of plage contrast at several values of disk center distance. This work is mostly complete.

(3) Observations need to be made specifically to determine seeing corrections for the data.

It is expected that this work will be completed and published soon.